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Reduction of Machine Breakdown in the Brewery Manufacturing Company, A Case Study of Brewery "A" in the Eastern Nigeria

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ABSTRACT

In this study, the machine break down pattern in Brewery "A" in Eastern Nigeria situated in Onitsha Anambra state has been considered. In the first step of this study, structured questionnaires were produced and administered to target audience for primary data collection. The brewery has limited newsletters, annual reports and bulletins that were used in addition for the reviews. The machines used in the packaging department and its breakdown data over a period of twelve months were gathered and from this, the frequency of breakdown of the machines were established and the data analyzed. The analysis was done by evaluating bottleneck machine breakdowns for different work stations in the production plant, and the effects of breakdown on system output. As a result of the study, critical rates of machine breakdown, which have affected system output, were determined. The frequency of machine breakdown, downtime and maintenance failure problems were also identified. Data collected were analyzed and model for optimization developed. Root cause analysis tools–fishbone and "5why" were used to eliminate the frequent occurring machine breakdown. Mean Time to Failure (MTBF), Availability, and Mean Time to Repair (MTTR) values for the various production lines were evaluated before and after root cause analysis. The result shows that a percentage increase of 13.66%, 10.62% and decrease of 46.42% respectively were obtained which indicated improved Factory efficiency, machine availability and compliancy to plan. Also, Exponential distribution model was used to calculate the failure rate and reliability of the machines using the reliability measures result obtained after root cause analysis technique was applied to each failure. A reliability of 99.7% was obtained.

Keywords: Problem solving; Root cause analysis; 5why; Fishbone analysis; Downtime/breakdown; Availability.

1. Introduction

Every conversion process keeps seeking for the most efficient way of utilizing resource inputs in order to optimize the process and production which in turn reduces unit cost (Meyers and Stewart 2005). In production plants, there are so many unplanned stoppages during production leading to downtime example machine breakdowns, raw material unavailability etc. No matter the circumstance, the production company has to meet customer's demand to be in business or they will face loss of their customers, so it is important to deal with all forms of downtime before it starts impacting on the business.

Manufacturing business is very unstable in nature and can face various setbacks or challenges which can affect output and performance entirely. These setbacks includes machine breakdown which is the area of concentration in this work. Machine breakdown is an important factor in production facility therefore production planners must be cautious during maintenance scheduling and planning to completely eliminate machine stoppage during production by improving the machine's reliability and availability, by so doing, timely production targets are met and the machine will invariably always be in good condition making it easier and safer to work with.

According to Globerson and Parson (2013), the key elements in manufacturing system are machines, and its breakdown can drastically affect performance of the manufacturing system. Adler (2000) also emphasized that what a machine breakdown stops a production process, the workstation at which this breakdown occurred is regarded as a critical station for the breakdown. Considering this critical workstation, the parts or output of this station can be reserved in a buffer area so that production can still continue in case of breakdown of such station.

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Principally downtime (from any source) can be reduced to the barest minimum without affecting or compromising the quality and performance of the output (whether product or services). To be in business, manufacturing companies should adopt a way or system of keeping downtime in check and thereby improve efficiency, productivity and the organization at large Niebel et al., 2008.

2. Material s and Methods

2.1. Materials

The materials used for this research include the following:

- Oral interview/interaction with some selected staff of in the brewery Onitsha.
- Use of the company's journals/magazines/bulletins and data storage systems.
- Use of the libraries.
- Research on internet.
- Maintenance log sheets.

2.2. Data collection

Data Collection is very vital in this research study. Inaccurate data can impact on the results of a study leading to invalid results. Machine failure, downtime and maintenance history is vital for investigating the Root Cause of a problem.

Data also gives the basis for:

- Defining the current performance.
- Identification of root cause.
- Measuring progress.
- Testing effectiveness of solutions.

2.2.1. Aim of the data gathering

1. Evaluate the data to establish **what** happened as it occurred.
2. Look at **how** it happened.
3. Establish **why** it happened.

2.2.2. Failure

The data about the causes of breakdown were also collected in form of:

i. Breakdown time.

ii. Repair hours, inspection time and maintenance action taken.

iii. Parts changed.

Asian Journal of Applied Science and Technology (AJAST)
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iv. The data also include reasons for failure related to machine, material, process, environment etc. These information, after analysis, will be useful in the availability improvement attempt.

The data used for this work is data collected from the maintenance archive/record in brewery company Onitsha, and also information provided by the maintenance team and specialists

3. Results & Discussions

Table 1.0. Downtime Sources, Frequency and its Degree of Occurrence

Downtime source	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Machine	17318	18216	17571	21811	20811	15516	18061	18691	16236	15852	17666	18584
Operational (man)	10	0	0	5	13	0	0	4	0	0	0	27
Materials (CAN, bottle, crate, label, crown cork etc)	175	277	180	21	115	228	217	101	156	108	138	115
Accident	0	0	0	1	0	0	0	0	0	2	0	0
Utilities supply	215	305	117	205	414	59	65	72	137	149	162	138
Program/software error	12	34	15	0	33	68	49	12	0	4	10	41
Others (jam, trip, dirt carryover etc)	50	44	13	51	62	38	66	75	49	22	61	17

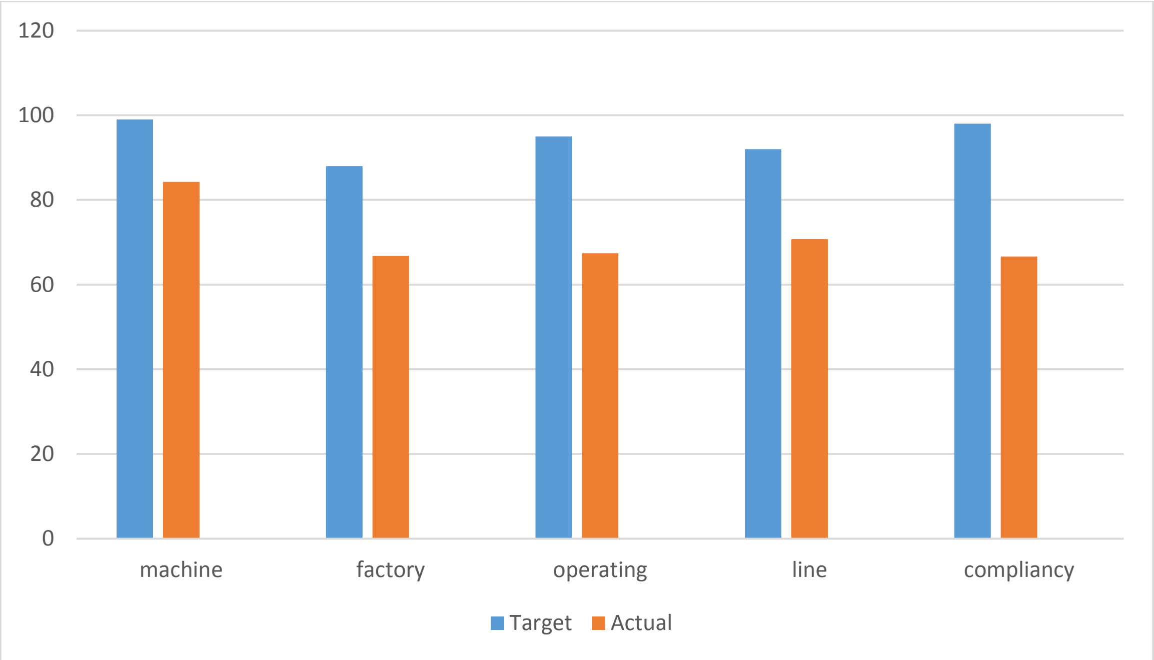

Figure 1.0.

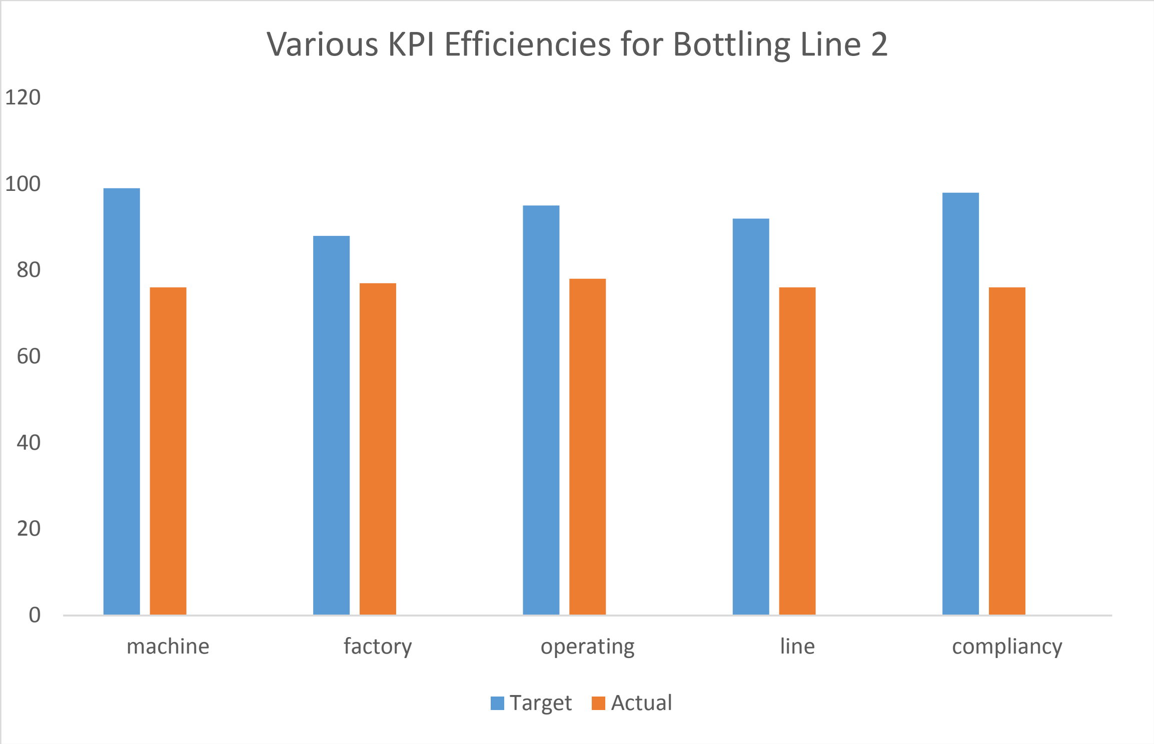

Figure 2.0.

Table 2.0. Maintenance Cost (From August 2015 to July 2016)

Month	Maintenance cost in naira (#)
August	10,863,792.93
September	10,072,550.51
October	13,360,266.22
November	15,388,173.04
December	12,825,811.26
January	19,735,682.48
February	21,975,705.88
March	19,607,159.38
April	12,023,906.46
May	13,485,335.19
June	18,929,708.97
July	14,836,231.43

Asian Journal of Applied Science and Technology (AJAST)
Volume 7, Issue 3, Pages 65-74, July-September 2023

Table 3.0. Bottling Line 1 Machines, their break down pattern and down time record over a year period

Machine/ Downtime incurred (mins)	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**
Depalletiser	249	181	262	193	106	128	170	143	127	148	233	167
Palletiser	212	190	175	168	159	173	148	157	123	106	154	1183
Pallet magazine	40	17	54	16	70	55	69	56	102	33	159	17
Crate conveyor	37	34	46	122	18	37	154	109	123	44	69	106
Bottle conveyor	255	313	196	249	332	149	271	178	136	114	228	143
Packer	146	209	241	268	270	183	174	162	198	187	175	162
Unpacker	447	359	182	355	277	319	452	313	285	177	184	464
Crate washer	179	183	113	172	209	216	177	185	162	152	138	173
Bottle washer	258	309	352	388	371	358	260	359	318	264	208	354
Filler	2372	1300	1269	1311	1362	1481	1533	1540	1451	1316	438	1515
Empty bottle inspector	147	146	150	175	108	131	239	176	138	144	105	152
Full bottle inspector	102	110	97	148	116	129	133	154	162	184	175	116
Full crate inspector	48	20	59	162	83	179	156	108	137	44	66	40
Video jet (for coding)	56	140	136	104	16	29	437	153	116	145	179	188
Pasteurizer	129	136	187	152	329	326	148	176	179	168	174	47
Labeller	871	583	742	651	718	577	950	500	471	586	612	347

Asian Journal of Applied Science and Technology (AJAST)
Volume 7, Issue 3, Pages 65-74, July-September 2023

Table 4.0. Downtime Sources, Frequency and its Degree of Occurrence

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The production department runs on a 24hours daily production plan (except on maintenance day) and this is divided into a three shift plan, one runs during the day (7am-6pm) and the other at night (7am -6pm) while one is on off duty.

With 22 days production time period, the maximum production time per period is calculated thus:

Max production time (in seconds) = 22 x 24 x 60 x 60 x 60 = 190800s.

From the data gathered and tabulated above, it was established that:

1. The main source of down-time are machines

2. In all the production lines, the machine with the highest down time(unplanned stop during production) are the filler, labeler and the pasteurizer (in their order of occurrence)

3. The stoppage of one machine causes the entire production line(other machines) to be idle

Therefore the Root cause analysis for downtime minimization was focused on these machines addressing their common/frequent causes of failure.

As earlier discussed, Root-cause Analysis is a method used to fix a problem of non-conformance in order to get to the ―root cause of the problem. It is aimed at correcting or eliminating the cause, and prevent the problem from resurfacing. **Root Cause** is the factor that, when it is gotten right, the problem disappears and doesn‘t come back.

Asian Journal of Applied Science and Technology (AJAST)
Volume 7, Issue 3, Pages 65-74, July-September 2023

4. Conclusion

This project was carried out on the machines in the production line of Intafact beverages Onitsha, and all repeated breakdowns were analyzed along with the critical parts, which has been under breakdown condition is also identified and analyzed . Also the reason for the breakdown has been analyzed and some of the tools of root cause analysis like 5-why analysis, fish bone diagram were implemented to identify the actual cause of the breakdown. By this analysis and methods, the root causes of the machine breakdowns were identified. This in turn helped to develop and improve a new preventive maintenance checklist for the machine. This method is used to prevent the failure of equipment before it actually occurs. The average availability of critical machine like the filler after root cause analysis is increased by **10.62%**. Also the average MTBF of the critical machine after root cause analysis is increased by **13.66%** and MTTR is decreased to **46.42%** respectively. After root cause analysis there is an improvement in the maximization of planned productivity. This is because of proper diagnosis of the existing system and by employing proper preventive maintenance schedule. Therefore whenever a breakdown occurs, the root cause of the breakdown has to be identified. Then some efforts should be made to improve this system using root cause analysis and counter measures, such that similar type of breakdown can be reduced.

Therefore this work resulted in:

1. Reduced machine downtime during production.
2. Increased machine availability.
3. Increase in machine/factory efficiency by an increased MTBF and decreased MTTR.
4. Increased Overall Equipment Effectiveness (OEE).
5. Improved safety and quality conditions.
6. Improved Factory efficiency.
7. Improved Adjustable factory efficiency.
8. Improved Machine efficiency.
9. Improved Compliancy to plan.
10. Improved Line efficiency.
11. Improved Operating efficiency.

Further results achievable at the long run as a result of this work which will include but not limited to:

1. Reduced overtime costs and more economical use of maintenance workers due to working on a scheduled basis instead of a crash basis to repair breakdowns.
2. Timely, routine repairs circumvent fewer large-scale repairs.
3. Reduced cost of repairs by reducing secondary failures.
4. Identification of equipment with excessive maintenance costs, indicating the need for corrective maintenance, operator training, or replacement of obsolete equipment.
5. Parts stocking levels can be optimized.

5. Contribution to Knowledge

With the results achieved in this work, facts have been established that effective Root Cause Analysis can minimize machine failure during production. Tasks as little as cleaning has shown to have an impact on the performance and availability of machines.

6. Recommendation

For future further research, condition monitoring as an effective tool in reliability Engineering can also be explored in the quest to cut down on unwanted machine stoppage during production (down time) because of its predictive nature. In the cause of this work it was noted that this is yet to be fully utilized and implemented. If this will be implemented together with and effective root cause analysis tool, the company will meet and surpass its target thereby improving on its key performance indicators.

Also a mechanism for downtime documentation should be developed in order to track every second of production time wasted, for example software should be installed in machine's program to enable it capture every stoppage and prompt the operator to input reason for stopping before starting up again, with this accurate downtime tracking will be established instead of relying on operator alone for reporting downtime. This will give more detailed downtime information especially in terms time which has economical implication on the company.

Declarations

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Competing Interests Statement

Authors have declared no competing interests.

Consent for Publication

The authors declare that they consented to the publication of this research.

Authors' Contributions

All the authors took part in literature review, analysis, and manuscript writing equally.

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Volume 7, Issue 3, Pages 65-74, July-September 2023

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